Synopsis of research work

On

A STUDY ON ENABLERS AND CHALLENGES IN ADOPTION OF TECHNOLOGY BY NORTH INDIAN DAIRY FARMS: A SYSTEMS APPROACH

In

Pursuance of the requirements for the award of the degree of

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SUBMITTED BY

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SECTION 1

INTRODUCTION

The milk is a necessary requirement and an indispensible commodity for human life. There is no perfect substitute for milk. The milk is a base raw material for various dairy products such as ghee, yoghurt, cheese, butter, cottage cheese etc. All these are the processed forms of milk. India is the largest producer as well as consumer of milk in the world consuming almost its whole milk production. Dairy sector in India has been a significant contributor to the gross domestic product (GDP) with a value of approximately 26,000 million USD (Deshmukh, 2014). As per the Dairy market Review report by Food and agriculture organization (F.A.O., 2016-17) of United Nations, the worldwide milk output reached 811 million tonnes in the year 2017, which is 1.4% higher than the milk production in 2016. Out of this, 1.9% hike in the output is seen in the Asia with India and Pakistan compensating the decline in other Asian countries. India has shown a positive growth of 3.9% from 2016 to 2017. Initially in 1970, the Indian milk production was only limited to 20 million tonnes. In 2016-17, the country produced 165.4 million tonnes that is around 19% of the global milk production (Miranda, et al., 2017) with per capita availability of 355 gms/day. This made India to become the largest milk producing country followed by United States of America. But the rise in the milk production level is at a slower pace in comparison with the rise in the demand (NDDB report).

The major Indian state contributors involve:

Rank	**State**	**Production in 2016-17 (In million tonnes)**
1	Uttar Pradesh	27.77
2	Rajasthan	20.85
3	Madhya Pradesh	13.44
4	Gujarat	12.78
5	Andhra Pradesh	12.18

Table 1: State-wise milk production in 2016-17

(Source: Department of Animal Husbandry, Dairying & Fisheries, Ministry of Agriculture and Farmers Welfare, GoI)

The credit of this growth is given to 'Operation Flood Programme' launched by Dr. Verghese Kurien in 1970 at NDDB. In 1989, Technology mission on Dairy Development (TMDD) further

supported the operation flood with similar objectives. The final result of the programme was reflected through increased per capita milk consumption, the end of import dependency and the improved quality of milking animals. In 2006, India got the popularized white revolution by becoming the largest producer as well as consumer of milk *(Source: Indian mirror).* The dairy sector of India has shaped lives of millions of dairy farmers because dairy farming is considered as the most important occupation after agriculture (Quazi, 2012). There are presently 22 state milk-marketing federations in the country with AMUL (managed by Gujarat Cooperative Milk Marketing Federation, GCMMF) being the most popular milk union member of the federation. The contribution of unorganized dairy sector has a share of approximately 70%. GoI has various plans for the development of the dairy sector and as per current NDP (National Dairy Plan 2016 to 2020), the sector is aiming to double the milk production by 2020 with maintaining the CAGR of 15% amounting INR 9.4 trillion from INR 5.4 trillion during 2010 to 2015 level. The NDP has a focus of increasing the breeding rate from 50 million to 90 million with promoting artificial insemination technology and the support in this regard is given by National project on cattle and buffalo breeding (NPCBB) to tackle breeding related issues. With the spread of the Internet, a web portal has been created by the government namely- Dairy Knowledge Portal. The apex body National Dairy Development Board (NDDB) has launched a handbook that reiterates its commitment to the dairy farmers in India to take better care and management of the animals like breeding, nutrition, healthcare management, etc.

Milk; being a necessity item and the base raw material of the dairy products, the value deliverance of dairy farms in terms of quality and quantity is a main focus. The dairy farms are the primary stage of milk procurement and the overall farm-productivity is an important concern, which currently is not as per the expectations. The farm-level productivity depends upon the productivity of each milking unit in the farm. In case of India, the average yield per milking unit is very low i.e. 9.2 kilograms (5.2 for buffalo and 4 for cow) in comparison to U.S.A. where it is 27.8 kilograms (Nozaki, 2017). Some of the dairy farms have their own distribution channel and market. The farm itself manages the further stages of dairy supply chain as forward integration (Petare, 2012). This enhances the scope of dairy farm operations

and the elements of value deliverables are expanded. The global practices show that there are several ways for maximizing the value of the dairy farms through adoption of technology. In Indian context, there are several challenges at dairy farm level that are indicated in the previous studies like cost, capital, infrastructure, awareness, technical and managerial assistance, skilled manpower, etc. For any sort of adoption there is an analysis between benefits that will be achieved and the cost to bear for it. This calls for identification of the list of various enablers and challenges for the adoption so that appropriate strategy may be developed for value maximization.

1.1 Dairy farms in India

In Indian context the dairy farms are commonly referred as *Gaushalas* that means a shelter home place for milking animals such as cows and buffaloes (Shabdkosh). There are various categories of dairy farms in India (Mishra, 2016) such as:

- **Small-scale dairy:** Less than 50 cattle head
- **Marginal-scale dairy farms:** 50 – Less than 300 cattle head
- **Medium-scale:** 300 – Less than 1000 cattle head
- **Large-scale dairy farms:** 1000 and above cattle head

1.2 The Milk Co-operatives system in India

The co-operative society is a voluntary association of people who contribute their resources and energies for some common goal (Source: Collins Dictionary). The Gujarat based co-operative societies system in Indian dairy sector has a vital role to play in the supply chain. According to International Dairy Federation (IDF) survey of 21 countries performed in 1984 revealed that out of 55% of world's milk supply, the producer co-operatives marketed 86% of the total sales of milk from farms. At present there are more than 18,500 milk cooperative societies spread across the state of Gujarat and it has given the inspiration to more than 1,50,000 societies in the Nation spread among 23 milk federations (Source: Forbes India).

The concept of dairy co-operatives has made a significant contribution on the social as well as economic life of the dairy farmers. The purpose of the white revolution (2006) is seen in the

villages through the funds generation for social welfare, community development, and enhanced self-employment opportunities. The dairy co-operatives and federations have developed the modern systems of veterinary health care through van services equipped with a veterinary trained surgeon and required medicines for helping the cattle farmers with artificial insemination technology assistance (Rajeshbhai, 2011). The use of Information and communication technology (ICT) at the dairy supply chain in rural areas (called as e-experience) is provided by AMUL is another benchmark for other players of the country (Bowonder et al., 2003). The GCMMF has proved that a properly designed and implemented ICT could benefit the rural people and the dairy sector as a whole. This has enabled ease of digital payments to cattle farmers, maintaining the DBMS based records of the farmers with the milk supply details, keeping GPS tracking of milk transportation to avoid wastage.

The milk co-operatives have a dominant market share in the dairy sector and it has managed to maintain it in the face of competition by the private sector. The model of co-operatives in the dairy sector inspired other sectors of the economy and it has expanded to other production and marketing sectors as well.

1.3 Supply chain management in dairy sector

Supply chain management is the most important task as well as challenge for the FMCG (Fast-Moving Consumer Goods) food items especially the dairy products due to the perishability (Mor et al., 2017). The supply chain management is referred to as the cold chain management as far as the logistics of dairy products is concerned. Whenever a desired low temperature uninterrupted logistics is required, such a supply chain is termed as cold chain. If cold chain (refrigerated transportation) is not effective then it leads to high volume of wastage (Zhang et al., 2017). Cold chain logistics is studied for every perishable commodity and it has certain transportation related issues to be addressed (Joshi et al., 2009). There are various determinants of competitive advantage for the dairy businesses and cold chain management being the most important in the dairy value chain (Ding et al., 2018).

In order to avoid transportation from farmers to plant, some dairy farms establish their own organic farms for providing high quality fodder to the cattle in order to make more productive milking units but land availability and cost consideration is a question.

Indian population residing in rural areas accounts for the majority of milk production with the whole family engaged in dairy work like in case of New Zealand. Since major part of India is rural, it is a fact that there is a significant contribution of dairy sector in Indian economy. The rural people of India, who keep their own cattle for producing milk, consume 50% of the milk themselves and distribute locally and this accounts for the unorganized dairy sector of India (Nozaki, 2017).

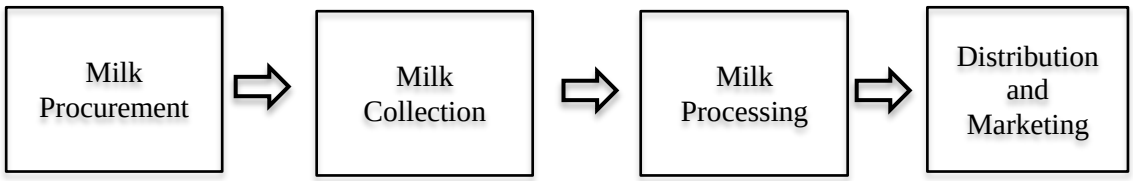

Figure 1: Basic co-operative society based supply chain of organised dairy sector of India

The supply chain of co-operative society system as a part of organised sector of Indian dairy sector can be understood as:

Milk Procurement

- The primary stage in the milk procurement is the **cattle farming** stage. The milk production takes place in the cattle farms or by the local cattle farmers. Some of the medium and large-scale dairy farms- process, distribute and market the milk on their own.

Milk Collection

- The **co-operative societies** collect the milk once or twice in a day from the local cattle farmers or dairy farms of the nearby areas. They either employ a collection person and vehicle to get the milk or the cattle farmers deposit the milk at the co-operative society centre. The payments to the suppliers are made on daily or weekly basis. Generally, a milk co-operative society comprises of a milk tester, collector, accountant and an

administrator who is responsible for running the centre. The milk quality (fat, protein content etc.) is checked by milk and the collected milk is dispatched through large vans and the vehicle selection plays an important role (Shabani, 2015). If the milk union is more distant, then some co-operative societies have their own chilling plant in order to secure the milk quality. The co-operative society may sell the excess procured loose milk to the people.

Milk Processing

- Further, the district-level **Milk unions** receive the milk from co-operative societies or directly by a collection agent for processing milk and milk products like ghee, yoghurt, butter, cheese, flavored milk, milk powder, ice cream, cottage cheese (paneer), etc. The manufactured items are packed with the brand name for example; AMUL (Anand Milk Union Limited) is a Milk Union. The role of milk unions is to provide macro-level inputs and training facilities to the cattle farmers and co-operative societies as an act of supplier development, which is an essential task in case of milk supply chain (Yawar et al., 2018).

Distribution and Marketing

- Then comes the role of **Milk federation** at state level that is responsible for the marketing of milk and milk products, and their movement across the state. The various milk unions are the members of the federation and they subscribe through a share capital. The federation tests the quality of product supplied by milk unions, and then it is released after certification. The federation coordinates with the government (state as well as central), National Dairy Development Board (NDDB) and other agencies like National co-operative dairy federation of India (NCDFI) limited.

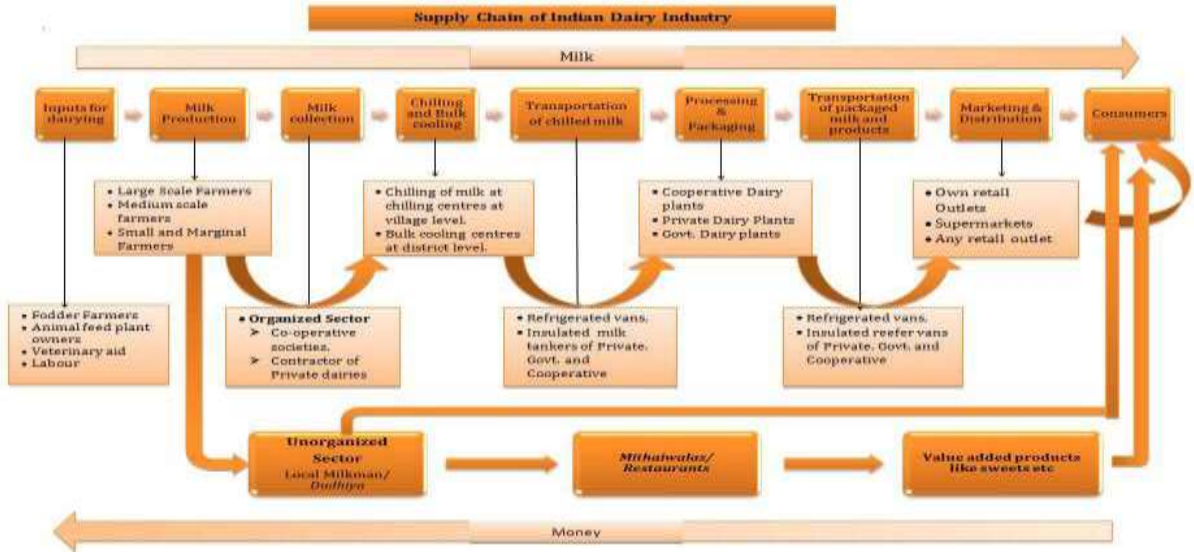

Figure 2: Expanded dairy supply chain if India
(Source: Petare, P.A. (2012). "Issues and Challenges of Supply Chain Management with perspective to Indian Dairy Industry"

1.4 Role of technology in Indian dairy farms

The role of technology in the business world created a tremendous growth. It is evident that the traditional business functions, models and concepts are revolutionized as an outcome of the inception of technology. It is because the technology has given an innovative and better approach to carry out business. It has provided a convenient, smooth and more efficient method of performing the business. Many firms irrespective of their product or service orientation have realized that there has been a drastic positive change in the business processes leading to the reduced costs and improved profits because of technology adoption from procurement to the delivery (Paul et al., 2001). The business revolution caused by the Internet and other technologies illustrates that the technology intervention is essential for the success of today's internet-based business enterprises. Therefore, as tomorrow's managers, entrepreneurs and business professionals, one must seek how to use and manage variety of information technologies to revitalize the challenges of dairy business processes (Mor et al., 2017) and gain competitive advantages with improved managerial decision-making, (Walse, 2016).

It is evident from global evidences that the implementation of technology delivers the value in terms of cost optimization, quality control, wastage reduction, achieving economies of scale,

efficient dairy resource utilization, improved yield/productivity, standardized processes, enhanced decision support system and overall management (Poranki, 2016).

1.4.1 The present scenario of technology in dairy farms

Technology is indicated as one of the major key focus area in order to strengthen the efficiency in dairy operations (Subburaj et al., 2015). The role of technology has been increasingly recognised beginning from the milk procurement from milking units till the manufacturing of processed milk and milk products covering all the stages in the way.

- The world is talking about the acceptability of ICT in dairy sector that includes ERP and IoT enabled dairy farm operations often termed as smart dairy farming (Lan, P.V.U. et al., 2017 and O'Grady, 2017).
- Concept like Radio Frequency Identification (RFID) tagging in the animals is to maintain the health records and monitoring the activity of the animal in the dairy farm (Mitchell, 2008).
- Genomic testing is another form of herd intelligence that has made the farmers to map the genome of a Holstein calf as early as one day after its birth**.**
- The computerized MIS (Donde, 2017).
- Digital dairy management (Nalla, V., 2017).
- Database dairy management. For example, 'InterHerd' is a software developed by Pan Livestock Services in conjunction with National Milk Records (NMR) and it is used throughout Europe and South America due to its flexible herd management, analysis and reporting ability (Binnington, 2014).
- The implementation of computer based dairy activities (Chopde, et al. 2015) helps in better preventive maintenance for example, the operator or technician in manual system and auxiliary equipment in the automatic system performs the operation of preventive maintenance as per the displayed instruction of computer based on the input data.

- The launch of web portal by NDDB is a form of ICT-based technology for providing training to cattle farmers on various issues. This helps in the automatic generation of break down and maintenance information required for management decision of optimum resource utilization. Using Hazard analysis and critical control points (HACCP) approach in dairy farms is also a form of systematic preventive and technological approach for milk safety from biological, chemical, and physical hazards in production processes that can cause the finished product to be unsafe and thus it reduces these risks to a safe level (Galstyan et al., 2016).
- Various other technologies have been also been introduced such as artificial insemination and Ovum Pick Up and In Vitro Embryo Production (OPU-IVEP) technology that allows 5-10 folds increase in the number of male calves produced from one elite animal for solving breeding related issues (Nehring et al., 2017)
- The installation of biogas plant technology helps in the waste management, installation of Automated milk collection units (AMCU), computerized milk testing through electronic milk tester.
- The 'precision dairy farming' that is the term given to the technology that measures and analyzes the physiological, behavioral and production indicators in individual animals.
- The installation of robotic milking system plants handles the complete task of milking the animals, maintaining data and packaging task (Dunn et al., 2007).
- The refrigerated GPS enabled transporting ensures the timely cold chain logistic of the milk to the plant.
- The digital payment to the cattle farmers is another dimension of technology adoption in this sector.

In Indian context, the cost is an obvious focus issue for such technologies (Yule et al., 2013). The IoT-based dairy farm operations in the form of robotic milking systems, automatic data entry system, etc. are gaining popularity throughout the world. But this is lacking in case of Indian dairy farms due to a broad range and multi-stage challenges. The technology and increased data

access are enabling dairy farmers to make smarter day-to-day decisions for improving the health of milking units, production and on-farm efficiencies (Schroeder, 2015). Also the developments in the field of biotechnology and pharmaceutical have created a huge impact on dairy sector through incorporating therapeutic value in dairy products (Singh, 2009).

Radio Frequency Identification (RFID):

This is one of the most common and widely adopted technology implementation in case of dairy business. RFID is basically a two-way communication chip that performs tasks on radio frequency. The chip is capable of working at remote places without Internet access.

In India, the milk cooperatives are taking initiatives for collecting animal nutritional needs, blood profile and the timely milk production data. *Chitale* Dairy situated in Pune city (Maharashtra) has started a project called "Cow on cloud". The objective of the project is to tag every animal of the cattle farms with a RFID tag. Ultimately, the tag will be gathering animal health, feed status and milk production data on a daily basis. Veterinarians can interpret the data and provide related recommendations to cattle rearer. The implementation of RFID tagging also enables tracking and locating of the animals (Jadawala, R. et al., 2018). This proposed research work would have a special focus on the adoption of RFID technology in the Indian dairy farms.

1.4.2 Technology implementation: The current status of Indian dairy farms

The Indian dairy sector has started to transform due to the introduction of various technologies (Seth et al., 2017). The health and life related a problem with the cattle is one of the main issues in the Indian dairy farms (Mathur, 2000). This is due to the inefficient health detection mechanism that can be resolved through ICT based monitoring or artificial insemination. Since past years, India has witnessed a negative growth in the bovine population that can affect the shortage in supply side in accordance with the demand. ICT-enabled monitoring can help to detect the animal health in advance and it facilitates the database management keeping the daily records of the cattle such as heat detection, movements (through pedometers), and appropriate

milking time, timely veterinary aids as per the animal status reflected on the screen, etc. Although under NDP I (NDDB), the initiative to establish Micro-Training Centre (MTC) has been quite successful for reaching out to farmers and promote new technologies on improved fodder production & conservation. Farmer-to-farmer education/technology transfer has been quicker as compared to other traditional methods. This overall brings productivity and life expectancy of the cattle that are the crucial live 'assets' in the dairy sector. The emerging trend is of the dairy farms that are crucial to fulfill the upcoming demands. Therefore, the technology spread in such farms is vital for profitable outcomes through effective management by technology adoption.

1.4.3 Information Technology implementation at Dayalbagh RSS Gaushala

This dairy farm is owned and managed by Radhasoami Satsang Sabha (RSS), Dayalbagh. The foundation of RSS Gaushala was laid in the year 1916 with one bull and three cows and the capital of two thousand Indian rupees and now the number of cattle head has reached one thousand. The role of this dairy farm is to cater the needs of its local people of Dayalbagh community rather than profit making and to make itself a self-reliant dairy farm. Over the last couple of years the RSS Gaushala is actively involved in the technology implementation across the farm activities (Mehra, 2017). Introducing proper management with the essence of basic technological techniques has converted the same previously existing herd into more productive one. Some technological involved in the Gaushala are:

- Database Management System (DBMS)
- Heat detection mechanism (for analysing appropriate breeding time)
- Radio Frequency Identification (RFID)
- Biogas production for waste management
- Total Quality Management
- Stress Management (Cattle)

As a result -

- The milk production level has increased from 1,050 litres of milk per day in 2014 to over 1,500 litres per day in 2017.

- The average milk production has increased from 5.75 litres per day to 7.5 litres per day in 3 years and it is aiming to further improve to 10 litres per day.
- The appropriate heat detection mechanism has resulted in overcoming breeding related issues and resulted in the improvement of average weight of calves from 18-20 kilograms to 26-28 kilograms.
- The accuracy of calving forecast is more than 90%.
- Due to efficient ICT-based health monitoring, the growth rate of calves has improved from 200 grams per day to 350 grams per day and deaths have reduced from 186 in 2014 to 128 in 2016 with a reduction of 31%.

Such a technology implementation specially the ICT enabled system is an effective way for improving other cattle farms across the country.

1.4.4 Sustainability aspect in dairy farm operations

With the advent of technology, the dairy farm operations are not only confined with the milk procurement but there are several other dimensions that are leading to the sustainable dairy farming. For example, RSS Gaushala work towards biogas production for the purpose of effective waste management. It has its own setup for this purpose. In addition to it, there are other by-products that come out of cattle farming activity such as the cow urine that has a significant medicinal utility. This is also bottled and sold at a good value. Thus, other than the eco-friendly aspect of sustainability, even as business perspective it is important for dairy farms in order to have maximized resource utilization and returns. This ultimately reduces the cost, minimize waste, delivers value and contribute to the environment.

1.5 Complexity of the problem

The milk procurement from the dairy farms has the high scope for meeting the increasing demands and hence it shows the opportunity aspect but at the same time, there are various challenges at the small, marginal and medium-scale farmers (Rangnekar, 2001). There are many established dairy farms across the country. Some are performing while most of them are struggling. The main reason for non-performance is the ineffective management of the milking units in terms of their health and productivity that effects the overall farm productivity.

The previous researches indicate that the technology intervention is a way through which the efficiency of dairy farms operations can be maximized (Janssen et al., 2017), as technology is one of the major driving factors for building the operational efficiency in the dairy sector (Subburaj, M. et al., 2015) (Quddus, M.A., 2012.). Also, the technology adoption has certain entry-level enabling factors (Akkeren, 1999) with possible implementation and maintenance related challenges acting as obstacles to achieve the value. The cost, infrastructure, awareness, technical and management assistance, skills, etc. are some of the major challenges. The global examples support the success story of technology implementation and its drastic impact on dairy farm productivity. Thus, it can be observed that certain numbers of enablers are pushing the adoption of technology while some challenges are restricting this adoption, where the overall purpose is to achieve certain types of value at the output like quality management, productivity enhancement, cost optimization, conformity, waste management, etc. in the presence of some moderating or uncontrollable factors that regulate the adoption of technology. Being in a same system, each and every factor acts as a sub-system and somehow these sub systems affects every other sub-system from same as well as other system and other sub-systems do affect them as well. This shows a non-linear complex scenario that can be understood through the following diagram where the overall factors are classified under Macro system and Micro system.

If visualized, all these factors are connected to each other in a complex web like structure where macro level factors do influence each other and also affect the micro level factors and vice-versa. At times, every variable act as a dependent variable and driving variables (that drive other variables) at some other point. Therefore, due to the presence of two dimensions, this creates a pluralistic scenario of ‘cost’ and ‘benefit’ trade-off between achieving the value and at the same time considering the cost, challenges and various other factors. Thus a strategic framework is required in order to make performing and profitable dairy farms in presence of such a complex system.

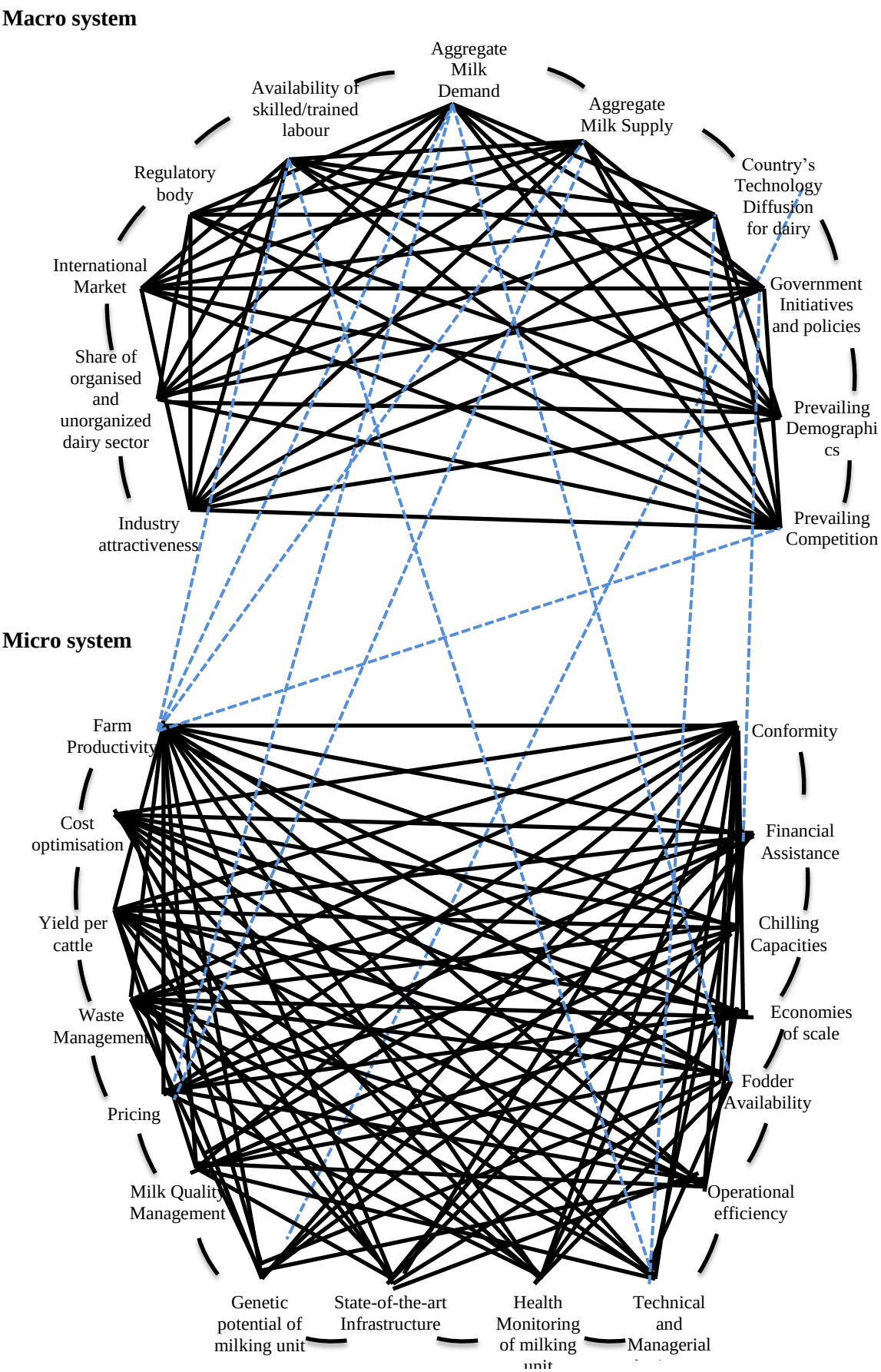

Figure 3: Complexity of the problem through structure-1

Another form of complexity is explained in the diagram below by picking up some variables from the reviewed papers/reports/articles and a relational structure for them is made in order to clarify the complexity created due to dependence of variables over other.

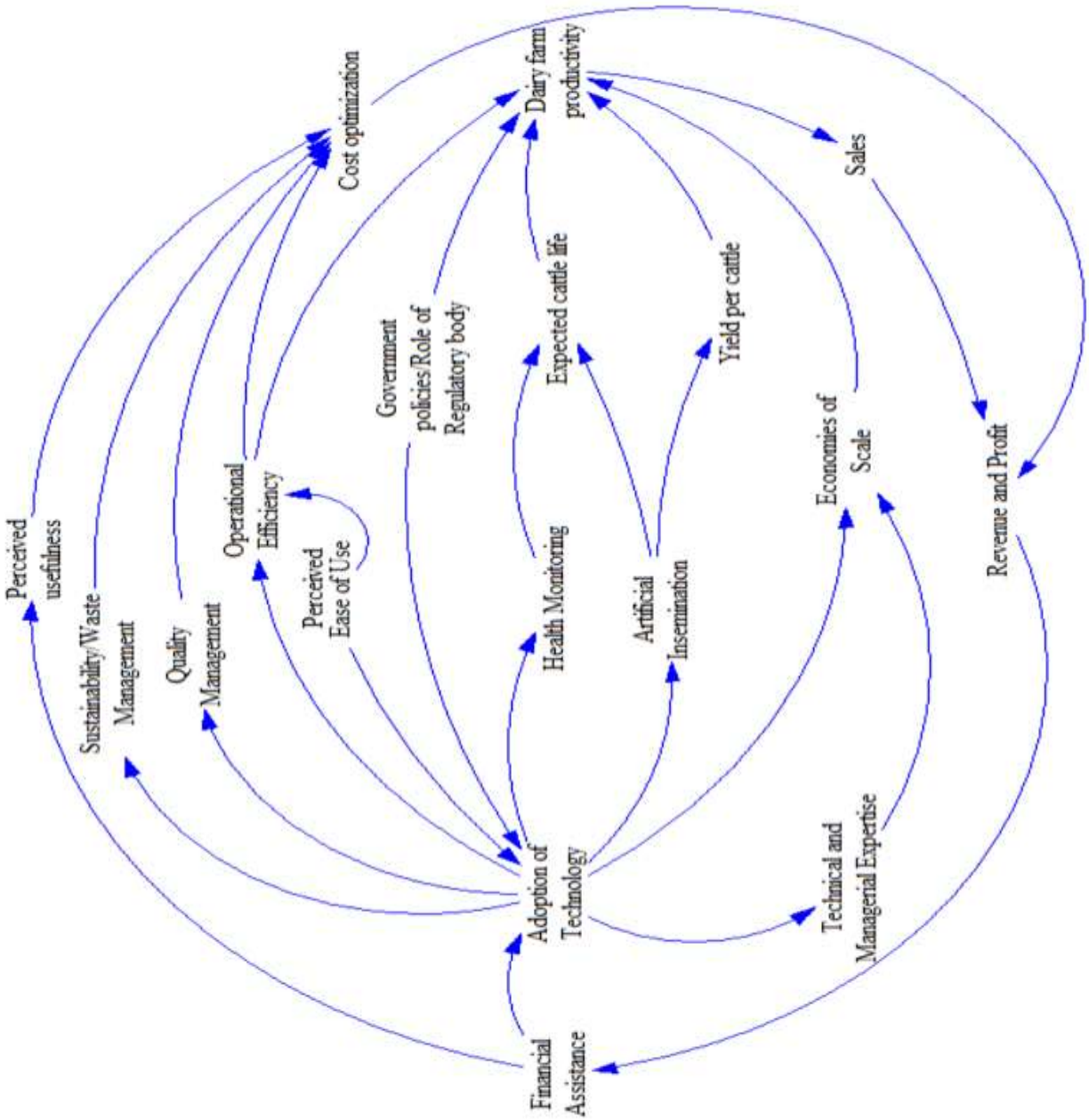

Figure 4: Complexity of the problem through structure-2

The source/reference of all the above-mentioned variables in the diagram is given below:

Davis, 1989 - *Perceived usefulness, Perceived ease of use*

Subburaj et al., 2015 - *Operational efficiency*

The Ohio state University extension, 2008 - *Cost optimization, Revenue/profit, Yield per cattle*

Bowonder et al., 2003 - *Artificial Insemination*

Petare, 2012 - *Technical and managerial expertise, Financial assistance*

NDDB report (2012 – 2017) - *Government policies/Role of regulatory body*

Nehring et al., 2017 - *Dairy farm productivity*

Mitchell, 2008 - *Expected cattle life*

Gillespie et al., 2014 - *Adoption of technology*

Singh et al., 2016 - *Waste management*

Deshmukh, 2014 – *Economies of scale*

Nalla, 2017 – *Sales*

Harisudha, 2017 – *Quality Management*

Mehra, 2017 - *Expected cattle life*

1.6 Systems approach to problem solving

The systems approach has been developed as a response with the increasing complexity of the socio-technical and managerial systems. Many techniques and approaches based on system philosophy have been developed which help in analyzing various problem situations in multiple ways (Sushil 1993).

Ludwig von Bertalanffy (1972) has reported extensive developments in the field of General systems theory and discussed the trends in System Science, Mathematical systems theory, Systems technology, and systems philosophy. The systems approach is broadly divided into 'Hard' systems and 'soft systems'. The evolution of applied systems thinking (or soft systems/flexible systems approach) has overcome the disadvantages that the hard systems approach possessed. When the businesses grew with rise in competition, several aspects emerged such as marketing, profitability, quality concerns, cost cutting approach, corporate

social responsibility, diversifications, etc. Therefore, it was realized that linear or hard systems approach might not be suitable for the solving the complex and pluralistic decision making problems and optimal strategy building. For this reason, soft systems approach emerged as a better ideology in response to the increased non-linear complexity in the business and the environment.

Checkland (1981) reviewed the systems movement. He concludes that the development had been more on the hard systems approach and suggested that the newer developments should be more on soft systems thinking with a 'learning' paradigm in order to solve non-linear complex problems.

Flexible Systems Approach

It is also termed as Soft systems or applied systems approach. The inspiration from the developments in system methodology in terms of schemes of systems techniques, and a wide applicability of integrated systems in computer-based management has been realized. Sushil (1993) generalized the philosophy of integration of techniques over the whole spectrum of system techniques in the framework of Flexible Systems Methodology (Sushil 1993). A specific application of this framework has been recently used in policy and strategy formulation (Saxena et al. 2006). This approach proposes that a flexible policy framework is needed to strategically meet the dynamics of the new era (Lie et al., 2018) where non-linear and pluralistic complex problems are prevailing due to the presence of several interacting sub-systems in a system. Flexibility paradigm in this context implies creating more "policy options" in order to have a broader policy choice, thus building "change mechanisms" in policy framework, and providing "freedom of choice" to all the stakeholders (Sushil 2000). Some of the main techniques in the soft systems approach for solving complex problems and strategy formulation are Interpretive Structural Modelling (ISM), Cross impact matrix multiplication applied to classification (MICMAC), options field/profile methodology, scenario building methodology, Delphic hierarchic process.

SECTION 2

REVIEW OF LITERATURE

The review of literature for the proposed research is performed to understand the basic concepts and insights of dairy sectors in India as well as abroad.

The reviewed literature comprises of 28 papers that focused the dairy supply chain practices and management. All the papers highlighted the issues and the challenges related to operational inefficiency in the dairy sector particularly the dairy farms. The obtained data in almost all the papers were survey based and some domain experts wrote the articles emphasizing the inhibitors of the dairy supply chain. In case of the organised dairy sector of India (that is around 30%), we see a multi-stage milk supply chain known as co-operative society system. Indian diary sector is currently heading more towards dairy farms rather than individual cattle farmers (Mishra et al., 2016) and there is a quick need to realize this trend and make attempts to promote dairy farms with high value deliverance. There were 23 papers and articles related to technology adoption in dairy farms and dairy sector as a whole. Some concerning with technology adoption or role of technology in dairy sector and some papers were focusing only upon the factors affecting technology adoption and management in miscellaneous industries. There are several factors that affect the technology adoption. These challenges may be related to cost, capability, awareness, resources, infrastructure, etc. (Patel, H., 2017). Most of the sectors have some or the combination of these challenges.

At global level, primarily in U.S.A., the dairy sector talks about technology involvement in the form of a concept called precision dairy farming (Schroeder, 2015). It involves a fully mechanized process of milking the animal till the task of testing, manufacturing and packaging. It has been indicated in that the future of the dairy sector lies in the hands of technology to bring out operational efficiency and value deliverance and the sector is driven effectively by the technology (Shah, 2001 and Sharma et al., 2012).

Yukiko Nozaki (2017) felt that in order to meet the constant increase in the milk demand, India has to channelize its unorganized milk sector into the organized one. As per the National Dairy Plan, India is aiming to reach 64% of its milk production through organized sector by the end of 2023. The most

common issue in the dairy sector is the milk procurement due to animal productivity i.e. yield of the bovines (Milking animals). NDDB with the help of Ministry of Animal husbandry and fisheries GoI is working to improve the health related and breeding related issues of animals with the help of RFID and artificial insemination technologies respectively.

Jadawala et al. (2018), suggested the need and pointed the importance of disruptive ICT (Information and Communication technology) based ERP (Enterprise Resource Planning) in the dairy sector especially at the cattle farming stage. Similarly, Vaughan J G Higgins (2016) analysed the dairy sector issues and suggested to implement the computer based dairy decision support system.

Classification of Literature Review: A broad classification of the previous papers is given as follows:

1. Focus of the paper
    - Supply Chain Management (Dairy or any other)
    - Technology adoption/Intervention in the firm/sector
    - Industry Analysis of the industry understudy
2. Context of the paper
    - Indian
    - Foreign
3. Type of Data for analysis
    - Qualitative
    - Quantitative
4. Research Design
    - Exploratory
    - Descriptive
    - Analytical

Summary of Literature Review													
Title ***Author(s) (Year)***	**Category**	**Literature Reviewed**	**Focus Issue**			**Context**		**Data Type**		**Methodology**		
			Supply Chain	**Technology**	**Industry Analysis**	**Indian**	**Foreign**	**Qualitative**	**Quantitative**	**Exploratory**	**Descriptive**	**Analytical**
Implications of disruptive ICT base ERP in dairy industry (In the aspect of Milk co-operatives and cattle farms) *Ravi Jadawala and Satish Patel (2018)*	Research Article		✔	✔		✔		✔				✔
An empirical evaluation of policy options for inclusive dairy value chain development in Nicaragua: A system dynamics approach *Helene Lie, Karl Rich, Rein van der Hoek and Kanar Dizyee (2018)*	Research Paper	✔	✔				✔	✔		✔		
Dairy Market Review *Food and agriculture organization of the United Nations (2018)*	General Review				✔	✔	✔					
Determinants of the competitive advantage of dairy supply chains: Evidence from the Chinese dairy industry *Huiping Ding, Yanan Fu, Lucy Zheng and Zhu Yan (2018)*	Research Paper		✔		✔		✔					✔
Smallholder dairy production and marketing - opportunities and constraints *NDDB (2018)*	Conference Paper				✔	✔						
Understanding the adoption of socially responsible supplier development practices using institutional theory: Dairy supply chains in India *Sadaat Ali Yawar, Katri Kauppi (2018)*	Research Paper	✔	✔			✔		✔		✔		
Digital Dairy Management *Vivekanand Nalla (2017)*	General Review			✔		✔						✔
Future trends of growing demand for milk and dairy products and milk supply in India *Yukiko Nozaki (2017)*	Research Article		✔		✔	✔						✔

Summary of Literature Review (Contd.)													
Title ***Author(s) (Year)***	**Category**	**Literature Reviewed**	**Focus Issue**			**Context**		**Data Type**		**Methodology**		
			Supply Chain	**Technology**	**Industry Analysis**	**Indian**	**Foreign**	**Qualitative**	**Quantitative**	**Exploratory**	**Descriptive**	**Analytical**
Factors affecting technology adoption: A review *Hemant Patel (2017)*	General Review	✔		✔		✔						✔
Technology adoption and value chains in developing countries: Evidence from dairy in India *Emma Janssen and Johan Swinnen (2017)*	Research Paper	✔	✔	✔		✔		✔		✔		
A structured-literature-review of the supply chain practices in dairy industry *Rahul S Mor, Arvind Bhardwaj and Sarbjit Singh (2018)*	Systematic review	✔	✔		✔	✔						✔
Benchmarking the interactions among performance indicators in dairy supply chain: An ISM approach *Rahul S Mor and Arvind Bhardwaj (2017)*	Research Paper	✔	✔			✔		✔		✔		
Digital technologies transforming Indian agriculture *Ankur Seth and Kavery Ganguly (2017)*	Research Paper	✔		✔	✔	✔			✔		✔	
Performing users: The case of a computer based dairy decision-support system *Vaughan J G Higgins (2016)*	Article			✔			✔					✔
The economics and productivity of US dairy farms that use crossbred vs non-crossbred breeding technology (production systems) *Richard Nehring, Richard Barton and Charles Hallahan (2016)*	Research Paper			✔			✔		✔		✔	
A study on evaluating supply chain risk and total quality management in dairy industry *V.M.Anitha Rajathi and Harisudha.R (2017)*	Research Paper	✔	✔			✔		✔		✔		
Compliance with Food Safety Practices Among Smallholder Dairy Farmers in Bihar, India: Drivers and Impact *Anjani Kumar Sunil Saroj Ganesh Thapa P K Joshi Devesh Roy (2017)*	Discussion Paper	✔			✔	✔		✔	✔		✔	

Summary of Literature Review (Contd.)												
Title ***Author(s) (Year)***	**Category**	**Literature Reviewed**	**Focus Issue**			**Context**		**Data Type**		**Methodology**		
			Supply Chain	**Technology**	**Industry Analysis**	**Indian**	**Foreign**	**Qualitative**	**Quantitative**	**Exploratory**	**Descriptive**	**Analytical**
Annual reports of National Dairy Development Board (NDDB) 2012-2017 *National Dairy Development Board*	Report				✔	✔						
The World dairy situation – 2017 *Gilles Froment and Nico van Belzen (2017)*	Report				✔	✔	✔					
An investigation into the dynamics of supply chain practices in Dairy industry: A Pilot Study *Arvind Bhardwaj, Rahul S Mor, Sarbjit Singh and Manish Dev (2016)*	Conference Paper	✔	✔		✔	✔		✔		✔		✔
Configuration of supply chain integration and delivery performance: Unitary structure model and fuzzy approach *Tritos Laosirihongthong and Premaratne Samaranayake (2016)*	Research Paper		✔		✔		✔	✔		✔		
The Efficient Supply Chain Practices in Indian Dairy Industry *Kameswara Rao Poranki (2016)*	Research Article	✔	✔			✔		✔				✔
Performance analysis and strategic planning of dairy supply chain in Indonesia: A comparative study *Aries Susanty, Arfan Bakhtiar, Nia Budi Puspitasari and Della Mustika (2017)*	Research Paper	✔	✔				✔	✔		✔		
Key analysis of the dairy value chain in Vietnam: The case of Bavi *Viet Khoi Nguyen (2016)*	Case Paper		✔				✔		✔		✔	
Barriers and facilitators of HACCP adoption in the Armenian dairy industry *Suren H. Galstyan and Tsovinar L. Harutyunyan (2016)*	Research Paper	✔			✔		✔	✔			✔	

Summary of Literature Review (Contd.)												
Title ***Author(s) (Year)***	**Category**	**Literature Reviewed**	**Focus Issue**			**Context**		**Data Type**		**Methodology**		
			Supply Chain	**Technology**	**Industry Analysis**	**Indian**	**Foreign**	**Qualitative**	**Quantitative**	**Exploratory**	**Descriptive**	**Analytical**
Implementing environmental practices within the Greek dairy supply chain Drivers and barriers for SMEs *Abhijeet Ghadge, Sonal Choudhary, Michael Bourlakis and Merilena Kaklamanou (2016)*	Research Paper	✔	✔				✔	✔	✔		✔	
Computer Applications in Dairy Industry *M.A. Deshmukh, S.S. Chopde, S.D. kalyankar and V.D. Kele (2015)*	General Review	✔		✔	✔	✔						✔
Specialisation and intensification of farming systems in Western China: The case of dairy farmers in Tibet *Colin G. Brown, Scott A. Waldron and John Francis Wilkins (2015)*	Research Paper	✔		✔	✔		✔	✔		✔		
Dairy Focus: Technology Will Drive Dairy Industry Progress *J.W. Schroeder (2015)*	General Review			✔	✔		✔					✔
Resilience of farmer-processor relationships to adverse shocks: The case of dairy sector in Poland *Jan Fałkowski (2015)*	Research Paper	✔	✔				✔			✔		
Factors affecting e-business adoption in SMEs: An empirical research *Prodromos Chatzoglou and Dimitrios Chatzoudes (2015)*	Research Paper	✔		✔	✔		✔		✔		✔	
A study on strengthening the operational efficiency of dairy supply chain in Tamil Nadu, India *M.Subburaj, T.Ramesh Babu and B.Suresh Subramonian (2015)*	Conference Paper	✔	✔	✔		✔		✔		✔		
A Framework for Sustainable Food Supply Chain: Reflections from the Indian Dairy Producers: Case study approach *Gyan Prakash (2015)*	Chapter Item		✔			✔		✔		✔		

Summary of Literature Review (Contd.)													
Title ***Author(s) (Year)***	**Category**	**Literature Reviewed**	**Focus Issue**			**Context**		**Data Type**		**Methodology**		
			Supply Chain	**Technology**	**Industry Analysis**	**Indian**	**Foreign**	**Qualitative**	**Quantitative**	**Exploratory**	**Descriptive**	**Analytical**
Business applications of information technology in dairy industry *R.S. Walse (2016)*	Research Paper	✔		✔	✔		✔	✔		✔		
India heading towards medium-scale dairy farms *Lalatendu Mishra and Shiva Mudgil (2016)*	Article				✔	✔						✔
A New Super-Efficiency Dual-Role FDH Procedure: An Application in Dairy Cold Chain for Vehicle Selection *Amir Shabani and Seyed Mohammad Reza Torabipour (2015)*	Research Paper	✔	✔	✔			✔			✔		
Interherd keeps tabs on performance. *Joanna Binnington (2014)*	Research Article			✔			✔					✔
R.S.S. Gaushala – Evolution of a living dairy management system". *Prakhar Mehra (2017)*	Case study	✔	✔	✔		✔						✔
Adoption of dairy farming technologies by small farm holders: practices and constraints *MA Quddus (2012)*	Research Article	✔		✔			✔		✔		✔	
Gains from coordination in milkfed dairy in Punjab *Kanupriya Gupta and Devesh Roy (2012)*	Research Paper	✔	✔			✔		✔	✔		✔	
A study on dairy industries in India *Mario Gabriele Miranda and S. Ramachandran (2017)*	Article				✔	✔						✔

Summary of Literature Review (Contd.)												
Title ***Author(s) (Year)***	**Category**	**Literature Reviewed**	**Focus Issue**			**Context**		**Data Type**		**Methodology**		
			Supply Chain	**Technology**	**Industry Analysis**	**Indian**	**Foreign**	**Qualitative**	**Quantitative**	**Exploratory**	**Descriptive**	**Analytical**
A case study of AMUL co-operative in India in relation to organizational design and operational efficiency *Ruchira Prasad and Rupali Satsangi (2013)*	Case study				✔	✔		✔				✔
Issues and Challenges of Supply Chain Management with perspective to Indian Dairy Industry *Purushottam A. Petare (2013)*	Article	✔	✔		✔	✔						✔
How IoT can help transform India's huge dairy market *Bazmi Husain (2018)*	Research Article			✔	✔	✔						✔
Technical efficiency and supply chain practices in dairying: The case of India *Surender Mor, Supran Sharma (2012)*	Research Paper	✔	✔			✔			✔		✔	
A Study of the Dairy Industry in India *Humera Quazi (2012)*	General Research Article	✔			✔	✔						✔
Evaluating supply chain risk in Indian dairy industry: a case study *Pramod Kumar Mishra and B. Raja Shekhar (2012)*	Research Paper with Case study		✔		✔	✔		✔	✔		✔	
An in-depth investigation on logistics practices for fluid milk and milk products in co-operative dairies in Gujarat *Shah Tejas Rajeshbhai (2011)*	Research Paper	✔	✔			✔		✔	✔		✔	
Indian cold chain: modeling the inhibitors *Rohit Joshi, Devinder Kumar Banwet and Ravi Shankar (2009)*	Research Paper	✔	✔			✔		✔		✔		

Summary of Literature Review (Contd.)												
Title ***Author(s) (Year)***	**Category**	**Literature Reviewed**	**Focus Issue**			**Context**		**Data Type**		**Methodology**		
			Supply Chain	**Technology**	**Industry Analysis**	**Indian**	**Foreign**	**Qualitative**	**Quantitative**	**Exploratory**	**Descriptive**	**Analytical**
Dairy farmers are milking wireless, RFID and censor technologies to keep herds fat, happy and profitable. *Robert L. Mitchell (2008)*	Magazine article			✔			✔					✔
15 measures of dairy farm competitiveness *Dianne Shoemaker Maurice Eastridge Don Breece Julia Woodruff Duane Rader David Marrison (2008)*	Conceptual Paper				✔		✔					✔
Robots Don't Get Sick or Get Paid Overtime, but Are They a Profitable Option for Milking Cows? *Jeffrey Hyde, James W. Dunn, Annette Steward, and Ellen R. Hollabaugh (2007)*	Case study	✔		✔			✔					✔
Factors influencing Technology Adoption: A review *Hemant Patel (2007)*	Conference Paper	✔		✔		✔						✔
Factors affecting entry-level internet technology adoption by small business in Australia – evidence from three cases *Jeanette K. van Akkeren and Angèle L.M. Cavaye (2007)*	Research Paper	✔		✔			✔	✔		✔		
Potential and Prospects of Dairy Business in Uttarakhand: A Case Study of Uttaranchal Cooperative Dairy Federation Limited *M.L. Sharma, Raka Saxena, Tirthankar Mahato and Dipan Das (2007)*	Case study	✔			✔	✔				✔		
Factors for Successful e-Government Adoption: A Conceptual Framework *Vinod Kumar, Bhasker Mukerji, Irfan Butt, and Ajax Persaud*	Conceptual Paper	✔		✔		✔						✔
Consumer attitudes to the use of two dairy technologies *K.M. Millar, S.M. Tomkins, R.P. White and T.B. Mepham (2002)*	Research Paper			✔			✔		✔		✔	

Summary of Literature Review (Contd.)												
Title ***Author(s) (Year)***	**Category**	**Literature Reviewed**	**Focus Issue**			**Context**		**Data Type**		**Methodology**		
			Supply Chain	**Technology**	**Industry Analysis**	**Indian**	**Foreign**	**Qualitative**	**Quantitative**	**Exploratory**	**Descriptive**	**Analytical**
IT innovation adoption in the government sector: identifying the critical success factors *M.M. Kamal (2006)*	Case Study	✔		✔	✔		✔	✔		✔		
Internet of things in agriculture: A case study of smart dairy farming IN Ontario, Canada *Poonssri Vate-u-Lan, Donna Quigley and Panicos Masouras (2017)*	Case Study			✔			✔	✔				✔
The adoption of technologies, management practices and production systems in U.S. milk production Jeffery Gillespie, Richard Nehring and Isaac Sitienei	Research Paper	✔		✔	✔		✔		✔		✔	
Modeling of an IoT enabled supply chain for perishable food with two-echelon supply hubs *Yingfeng Zhang, Lin Zhao, Cheng Qian (2017)*	Research Paper	✔	✔	✔								
Key performance indicators on dairy farms *Bjørn Gunnar Hansen, Grete Stokstad, Agnar Hegrenes, Erling Sehested, and Stig Larsen (2005)*	Article				✔		✔					✔
Information Technology Acceptance by Individual Professionals: A Model Comparison Approach *Patrick Y.K. Chau and Paul Jen-HwaHu (2001)*	Conceptual Paper	✔		✔			✔	✔	✔	✔		
Current Problems and Challenges Confronting the Dairy Industry in India *B.N. Mathur (2000)*	General Review	✔			✔	✔						✔

Table 2: Summary table of Literature Review

Summary of Research gap: Indian perspective

Although being the highest milk producing country in the world, currently India is the facing the issue of productivity, waste management, health management of milking units and other dairy farm operational issues that can be tackled through technology intervention. For any production unit, productivity is the most significant performance indicator and in case of dairy farms, the overall farm productivity is based on the individual productivity contribution i.e. yield per cattle. The focus of Indian researchers is on maximizing the supply chain related issues, but a separate focus is required on the dairy farms of the country as India is heading towards the trend of dairy farms and the productivity of the existing dairy farms is a major concern (Mishra, 2016). With the speedy rise in the population growth, there has been a negative growth rate of 6.5% in the population of milking units (National Accounts Statistics – 2016-17, GoI) and the current average yield per cattle per day in India is 9.2 kilograms where 4 and 5.2 kilograms as compared to 27.8 kilograms in U.S.A. and 22.5 kilograms in Japan (Source: FAOSTAT). As per the National dairy plan, India is targeting a huge rise in the milk production of 200 million tonnes by 2022 and the first hike in the demand will be reflected in the 2019-2020, for which the current supply level is insufficient (Bazmi, H., 2018). The productivity as a main dairy farm challenge involves the cattle health monitoring and management. The evidences from globally existing dairy farms indicate that with the technology intervention, the productivity of dairy animals and dairy farm management can be tackled efficiently. The technology has been accepted to be a major driver for the progress of the dairy sector (Schroeder, J.W., 2015). Many dairy farms across the globe have adopted, IoT based dairy farm management and Indian dairy farms are far behind this adoption. Although rare numbers of large-scale dairy farms have ICT and ERP based operations but that is not uniformly spread across all the dairy farms. Despite of the technology presence and various initiatives by the National Dairy Development Board (NDDB) in artificial insemination technology for resolving breeding related problems precision dairy farming methods, etc., the adoption is at a low pace in case of Indian dairy farms. NDDB reports indicate that still more than 21,000 villages are untapped to become organized dairy sector and for getting technical assistance. There are various enablers and challenges for technology adoption in case of the Indian dairy farms. Therefore, a strategic framework is required

in the light of existing enablers and challenges of technology adoption in the dairy farms so that the value of the farms can be maximized.

SECTION 3

CONCEPTUAL FRAMEWORK

There is always a purpose attached to any kind of adoption or transformation that is strategically relevant. In case of the business entity this purpose is the output received. The output has an importance as it conveys the success or the failure report and acts as an important performance indicator and the displays the competitiveness (Woodruff et al, 2008). The outcome can be tangible as well as intangible like in the form of conformity level achieved, satisfaction, etc. Thus it can be said that the output is a package of some variables called 'value' that each business attempts to maximize. The ultimate value maximization is possible when the tasks at each stage are collectively maximized as per their own defined standards. In case of the dairy farm - the technology adoption, management practices and production systems play a catalytic role that smoothens the dairy farm operations (Gillespie et al., 2014). Technology intervention is considered as strategic planning in case of dairy business to enhance performance and productivity (Susanty et al., 2017). Although we have popular models for technology adoption but the complexity covers the elements of more than one model and there is need to analyse the fit between the enablers and challenges of technology adoption by dairy farms acting with some external or macro level variables shown as moderators.

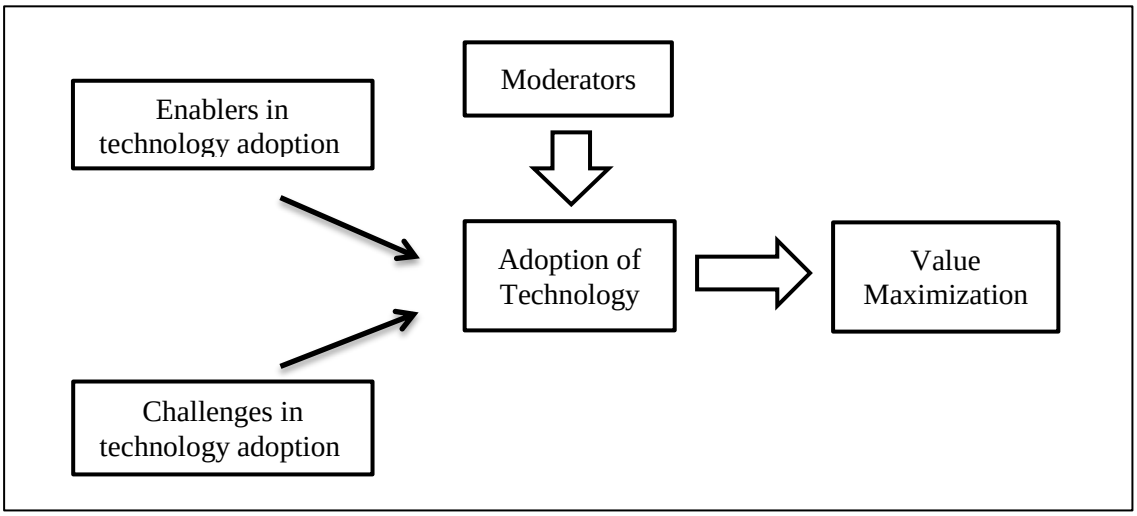

Figure 5: Self-Constructed Conceptual Framework

Enablers and Challenges for technology adoption: For any kind of adoption, there are some enabling or the driving factors that calls for the need of adoption. For example, there can be possible enablers for technology adoption like; Ease of use, Affordability, Easy availability, Perceived value, Government policies, etc.

The technology adoption in any sector is not a one-day task because several challenges are attached for such a major transformation (Chatzoglou, et al., 2016). The unorganized dairy sector has the 70% of the total share of the milk production in India. The Indian dairy sector is surrounded by a huge number of challenges on various aspects like herd-health related, breeding related, productivity related, storage related, logistics related, marketing related and farm-management related challenges (Petare, P.A., 2013). Consumer attitude towards technology is also considered as an important factor for consideration (Millar et al., 2002). The other researches by Ghadge et al. (2017) and Joshi et al. (2009) have shown that there are huge problems with small and medium-scale cattle farms due to inhibitors such as lack of finance, lack of technical awareness and assistance, literacy, infrastructure, medical facilities to the cattle, land availability for growing fodder for animals, etc. (Sharma et al., 2012).

Beside these enablers and challenges, other variables for technology adoption in small-scale and medium-scale dairy farms will be identified.

Moderators: Generally, moderator refers to such factors that moderate the adoption of anything. These factors are beyond the control of an individual entity. The moderating factors for technology adoption can be the role of concerned demographics, prevailing competition, etc. Rest will be identified in the research proceedings.

Value Deliverables: In general, the value deliverables for any type of business entity can be the conformity to consumer expectations, revenue/profit maximization, building competitive advantage, achieving economies of scale, cost optimization, meeting product or service standards, accuracy, reduced wastages, minimized rejection rates etc.

As per the literature review, there are several value deliverables in case of a dairy farm. The value deliverables are basically concerned with some measurable performance indicators like financial, operational or may be related to output-quality like expected customer conformity. For example,

as per AHDB (Agriculture and Horticulture Development Board, U.K.) some generic business financial indicators for agricultural farms (crop, poultry or dairy) are:

- Full economic cost of production [Less than 27.5 pence per litre (ppl) is excellent, 30 ppl is good and 34.5 ppl is average performing)
- Full economic net margin (7 ppl is excellent, 2 ppl is good and -3 ppl is average performing)
- Return on tenants-type capital (>20% is excellent, ~14% is good and ~3% is average performing)

The AHDB has also encouraged the concept called 'Strategic Dairy Farms' that ensures 'farmer to farmer' learning by hosting regular on-farm meetings and openly share their figures against their key performance indicators to show what can be achieved. There are some other financial indicators like income per cow, milk sold per cow, feed cost per cow, cost of producing 100 pounds of milk, rate of return on farm assets, debt per cow, etc. and there are some operational indicators like yield per cattle and overall farm productivity or milk output (Hansen et al., 2005).

As per the Dairy Excel (The Ohio state University extension, 2008) there are 15 measures of a dairy farm for measuring its competitiveness and those 15 measures fall into 10 broad areas, which together provide a good view of the competitiveness for a dairy farm business. The 10 areas are:

1. Rate of production
2. Cost control (Operating expense ratio, total cost per milk sold)
3. Capital efficiency (Dairy investment per cow and asset turnover ratio)
4. Profitability (Net farm income and rate of return on farm assets)
5. Liquidity
6. Repayment schedule
7. Solvency
8. Mission
9. Maintain family's standard of living
10. Motivated labor force

The above paper also highlights that the herd productivity is the main concern of the dairy farm and that can be improved using proven milk production technologies and resolving breeding related issues through artificial insemination technology as a strategic and competitive move.

Every business entity be it dairy business or any other, needs the maximization of the value deliverables to bring profitability and to remain in the competition. It is indicated in the past researches that the technology intervention improves the productivity related problems of the dairy farms. The productivity-improved results were seen in the RSS Gaushala of Agra city that has implemented the basic technologies and management systems (Mehra, P., 2017).

SECTION 4

OVERVIEW OF PROPOSED RESEARCH

4.1 Need of the study

It is noted that with a constant rise in population, there is a possibility of demand and supply gap in the coming years. The agricultural land requirement is primarily for satisfying the human needs and fewer land margins are there for animal fodder. Despite of being the highest milk producing country and the statistics show a hike in the overall production of milk, but the growth rate is not proportionate with the demand side (Punjabi, 2017). The population of milking units has been observed at negative growth rate of 6.5% (2012-2017, NDDB report). Also, the percentage share of gross value added (GVA) by the milking units in the agriculture (National Accounts Statistics – 2016-17, GoI) has dropped from 18% to 17.5%. The situation of Indian dairy items in International market is not impressive as it should be. Broadly, quality standards and quantity both are important value deliverables in case of a dairy farm. Thus it is essential for the existing dairy farms to enhance the operational efficiency as a core value deliverable in order to become profitable, cost optimizing, achieving economies of scale, revenue maximizing, and building-up competitive advantage. The country still has a lot of scope for such value maximization through technology intervention for satisfying the upcoming domestic requirements and to improve current productivity level in order to solve quantity related problem. The literature review reflects many issues and challenges beginning in the procurement stage i.e. the dairy farming stage due to

ineffective management and lack of technology assistance and implementation (Shekhar et al., 2012). Thus, technology acts as an effective tool to bring the operational efficiency and as a result to maximize the value of the dairy farm.

The Global evidences indicate that the involvement of technology delivers desirable improvements in the efficiency and the overall effectiveness of a dairy farm. The technology adoption in dairy farms is essential for total quality management of product as well as processes (Harisudha et al., 2017). The proposed research would help to understand the role of technology at the dairy farms and identifying various challenging and enabling factors for the adoption of technology with consideration of the complexity created by these factors. Also, strategic framework would be developed with the help of hierarchical model under system methodology to resolve the complexity. This research has been proposed by considering the aim of the National Dairy Plan to double the milk production till 2022. Thus the main purpose is to develop a strategic framework for maximizing the value deliverables of the dairy farms through the technology intervention.

4.2 Objectives of the study

The proposed research is aimed at accomplishing the following objectives:

Objective 1: To study the present status of adoption of technology in dairy farms.

Objective 2: To identify the enablers and challenges in adoption of technology in dairy farms.

Objective 3: To study the role of technology in value maximization of dairy farms.

Objective 4: To determine the optimal strategy and action plan for gaining the possible value maximization in dairy farms.

4.3 Research Methodology

4.3.1 Scope of the study

The proposed research will comprise the dairy farms of North India. Dairy farms from states like Uttar Pradesh, Punjab and Haryana will be included for the study, since these states have major clusters of dairy farms in North India and they are the largest milk producers in north zone.

State	**Annual Milk Production (`000 tonnes) in 2016-17**
Haryana	8,975
Punjab	11,282

Uttar Pradesh	27,770

Table 3: State-wise Annual milk Production in 2016-17

(Source: Department of Animal Husbandry, Dairying & Fisheries, Ministry of Agriculture and Farmers Welfare, GoI)

4.3.2 Sample Plan

Before conducting the NGT workshops, which is the main primary data collection technique under soft systems approach, the ethnographic survey would be conducted in the above-mentioned states in order to discover the present status of technology adoption in dairy farms. The aim is to explore the problems and brighten prospects based upon judgments and opinion of the experts of the sector for maximizing the value of the dairy farms through adoption of technology. On the basis of the state-wise list of registered dairy farms, it was found that Haryana has total 390 dairy farms (Department of Animal Husbandry and dairying, Govt. of Haryana), Uttar Pradesh has 510 dairy farms (Animal Husbandry department, Govt. of Uttar Pradesh). For this study, the proposed research will follow the following sample plan:

State	**Small-scale dairy farm (less than 50 cattle head)**	**Marginal-scale dairy farm (50 – Less than 300 cattle head)**	**Medium scale dairy farm (Less than 1000 cattle head)**	**Large-scale dairy farm (1000 and above cattle head)**
Haryana	5	5	5	5
Punjab	5	5	5	5
Uttar Pradesh	5	5	5	5

Table 5: Sample plan for study

4.3.3 Data collection

Primary Data: The proposed study is based on the application of the systems approach. The primary data in this case is collected through series of Nominal group technique (NGT) workshops with the panel of 10-15 domain experts.

Experts Profile: Since the proposed research is related to dairy sector, various dairy domain experts would be invited for the multi-stage workshops. The profiles of the domain experts would be academicians of owners and managers of dairy farms, academicians of dairy related teaching courses, managers/employees of established milk brands, representative from milk marketing federations and ICT experts.

Secondary Data: *(proposed)* Dairy sector annual reports issued by National dairy development board (NDDB) highlighting the technology adoption status in Indian dairy sector.

4.3.4 Tools and techniques to be used (proposed)

- **Ethnography:** Ethnography is a potent tool for the primary data collection. This involves detailed observations of the site understudy from where the information can be attained. For this, various dairy farms will be personally visited to know the performance and status of technology adoption.
- **Depth interviews:** The managers or the owners will be interviewed about the issues, problems, operating practices, and efficient methods of the dairy farm units.

Tools and techniques of Soft Systems approach

(a) Nominal group technique (NGT): This is a structured technique of data collection and ideally 10-20 participants give their ideas by writing on the slips. This technique was invented to neutralize the negative effects of group dynamics like it avoids dominating by some individuals. Thus it is a formalized form of brainstorming and decision-making. Firstly, a facilitator explains the issue to the experts and then each one has to jot down the points. There is no interaction among the members so as to provide an equal chance to everybody to express their views. The ideas are then recorded, displayed in front of everyone and discussed. Once the list of clear ideas is available, participants vote for the most important ideas to be selected.

(b) Delphi Method: Delphi method is used when face-to-face interaction is either not possible or not desirable. It is a strong structured questionnaire based survey method of capturing the experts' views about matters on which detailed insights are required. The results obtained from the first round are presented to the same experts for review purpose and their responses in the light of collective feedback are displayed and discussed with the group concerned. The results obtained after the second round are checked to verify the level of consensus and variance. If the desired consensus is found lacking, the whole exercise is repeated until the consensus is reached.

(c) Interpretive Structural Modelling (ISM): The ISM is a soft systems methodology that transforms, weakly articulated, complex mental models of systems into well-defined simpler models (Wilson, 2001). The process begins with identification of certain variables and defining relevance

relationship in a matrix form called SSIM (Structural self-interaction matrix) by experts. Based on the various matrices data, the resultant model or a graphical depiction (digraph) is constructed which provide information about hierarchy between the sub-elements in an element. A structural model provides a clearer picture and an understanding of contextual relationships.

(d) Indirect Relationships: MICMAC: The Cross impact matrix multiplication applied to classification (MICMAC) method is based upon the multiplication properties of matrices. The MICMAC graph segregates all the variables into dependent variables, autonomous variables, interdependent variables and driving variables. If variable i directly influences variable k and if variable k directly influences variable j, any changes affecting variable i can have a repercussion on variable j. Thus, there is an indirect connection between 'i' and 'j'. The direct relationship matrix as developed is taken as the base to start the process of finding the ranks of the variables considering the indirect relationships.

Fuzzy Considerations: The notion in the basic set theory is that an item is either a member or not a member of a set. However, in real life situations, certain sets have imprecise boundaries. A fuzzy set is characterized by a membership function, defined as a real number in the interval (0,1). Fuzzy considerations are incorporated in the techniques of systems analysis as well. In addition to the consideration of interaction between elements and sub-elements (binary relationships), it also considers various levels of the possibilities of interaction. This is done for both ISM and MICMAC and then it is referred to as Fuzzy ISM and Fuzzy MICMAC.

4.3.5 Phases of proposed research

The proposed research study will be conducted in the following phases:

Phase 1: Present status of technology adoption in dairy farms

In the beginning stage, the researcher will attempt to know the present status of technology adoption in the dairy farms of India using secondary data like dairy sector annual reports and other related sources. Also, personal visits to various dairy farms with interviews shall be conducted. The initial phase of nominal group technique (NGT) workshop will also be focusing on the exhaustive discussions and explanations on the present level technology adoption in the dairy farms.

Phase 2 – Identifying the challenging and enabling factors of technology adoption

The researcher will be identifying the enabling and the challenging factors for the technology adoption at the dairy farms. These factors will be identified through a workshop with the dairy domain experts through Nominal group technique (NGT) from various profiles like teaching professionals involved in dairy teaching courses, owner of dairies, dairy managers, representatives from governing bodies of Indian dairy sector and employees working in milk brands. The researcher will be using the system-theoretic tools like Idea engineering, idea writing, future projections, etc.

Phase 3 – Developing the Hierarchical Structural Model

At this phase, the researcher will be developing a hierarchical structural model under relevant contextual relations of the enabling and challenging factors identified in Phase 2. Depending upon the nature of identified factors, this may be extended for different contextual relations. The fuzzy Interpretive Structural Modeling (FISM) tool will be used in this phase. This phase will require interactive sessions with the domain experts. Later, on the fuzzy MICMAC analysis will be done in order to determine the driving and dependency power of identified factors.

Phase 4 - Finding Optimal Strategy and developing Dynamic Optimal Strategy

The last phase will involve determination of the optimal strategy and action plan for possible optimal level of value maximization. A causal loop diagram would be developed on the basis of the discussion or workshop session with domain experts. The system dynamics technique would then be used to conduct simulation analysis in order to come up with optimal strategy.

In addition to the above, the researcher may explore the use of related techniques like system dynamic modeling, Structural Equation modelling (SEM), Analytic Hierarchy Process (AHP), etc.

4.3.6 Brief outline of the proposed series of workshops

Workshop I- Title: Workshop on “Technology adoption in Indian dairy farms”

Venue: Department of Management, Faculty of Social Sciences, Dayalbagh Educational Institute, Agra.

Workshop II- Title: Workshop on “Enablers and Challenges for technology adoption in the Indian dairy farms”

Venue: Department of Management, Faculty of Social Sciences, Dayalbagh Educational Institute, Agra.

Workshop III- Title: Workshop on "Interpretive structural modelling for technology adoption in Indian dairy farms"

Venue: Department of Management, Faculty of Social Sciences, Dayalbagh Educational Institute, Agra.

Workshop IV- Title: "Strategic approach for technology adoption in Indian dairy farms to maximize the value"

Venue: Department of Management, Faculty of Social Sciences, Dayalbagh Educational Institute, Agra.

4.3.7 Case Study Approach

The researcher will include case study as a validation tool to support the claim of the reports and its finding. The application, reports and/or reported business model would also be explored as data source.

SECTION 5

PROPOSED CHAPTERIZATION

The proposed research will contain the following chapters:

- Chapter 1: Introduction
- Chapter 2: Review of literature
- Chapter 3: Status of technology adoption in dairy farms
- Chapter 4: Research design and methodology
- Chapter 5: Data collection and analysis
- Chapter 6: Results and interpretations
- Chapter 7: Strategic framework for gaining value maximization
- Chapter 8: Conclusion, Managerial implications, and direction for future research
- Bibliography and references
- Appendix

SECTION 6

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